

Diode split high voltage transformer
for a television receiver

The invention is based on a high voltage transformer according to the preamble of claim 1. Such a transformer contains a multiplicity of partial windings located in cells of a coil former and approximately the same number of diodes located, respectively, in terms of circuitry, between the partial windings but, in terms of spatial position, on the outer edge of the coil former between the partial windings. As not only the cells with the partial windings but also the diodes require a space in the axial direction of the coil former, there results, especially in the case of a multiplicity of partial windings and diodes, a correspondingly long coil former which increases the amount of space required and reduces the coupling.

It is the object of the invention to enable a multiplicity of diodes to be accommodated without the overall space requirement of the coil former with partial windings and diodes being increased by any significant amount.

This task is solved by the invention specified in claim 1. Further advantageous developments of the invention are given in the subclaims.

A high voltage transformer having a high voltage winding in a cellular coil former, in which two series connected diodes which - from a circuit point of view - represent a diode located between two partial windings, are located at a position of the outer wall of a cell wall, is also known (EP-A-0 033 450). The series connection of the two diodes occurs for reason of withstanding breakdown at high voltage because a single diode does not have sufficient resistance to breakdown for the pulses voltage in the high voltage winding.

Furthermore, a high voltage transformer is known (EP-A-0 201 335), in which a plurality of diodes, that are relatively displaced in the axial direction, are arranged on the outer edge of a cellular coil former. The diodes run at an angle to the peripheral direction of the coil former and thus they each extend in the axial direction of the coil former. Due to this arrangement, the layout for an

automatic manufacture of the coil former is simplified and, in particular, the radial separation of the terminal wires of the relatively long diodes from the coil former is reduced.

Therefore, with the invention, several diodes that are distributed around the circumference of the coil former are arranged around the periphery without any mutual offset in the axial direction. If, for example, four diodes are arranged on the outer edge of a cell wall, then the space requirement for the diodes in the axial direction is only one quarter of the space requirement in the known solutions where, in each case, only one diode is located on a cell wall. Since the total space requirement for the diodes in the axial direction is reduced, the overall length of the coil former is also reduced. Thus, an increased coupling between the primary winding and the secondary winding can, in turn, be achieved.

Therefore, with the invention, several diodes distributed around the circumference are always arranged on a circumference of the coil former without mutual offset in the axial direction. If, for example, four diodes are arranged on the outer edge of a cell wall, then the space requirement for the diodes in the axial direction is only one quarter of the space requirement in the known solution where always only one diode is located on a cell wall. As

the total space requirement for the diodes in the axial direction of the coil former is reduced, the overall length of the coil former also decreases. Thus, an increased coupling between the primary winding and the secondary winding can, in turn, be achieved.

According to a further development of the invention, each cell wall is provided with a ramp-shaped recess running tangentially from its outer edge to the cell base without completely interrupting the cell wall; the winding wire is fed through said recess from a diode terminal or a point of support to the cell base. This means that the winding wire places itself in the ramp-shaped recess and becomes spatially separated from the winding located in the cell. Thereby, in particular at the upper winding edge, a gap is created between the winding wire and the winding of the cell which already exhibits, in relation to the winding wire, a considerable voltage. In this way, the electric strength of the winding can be raised.

While, for example, four diodes are located on a circumference along a cell wall, the associated partial windings must of course be located in cells which are arranged following each other in the axial direction of the coil former. Owing to the fact that, in terms of circuitry, always one diode is located between two partial windings, when winding the partial windings in successive cells, the winding wire must be fed back to each diode. According to a further development of the invention, this is carried out by winding cells arranged successively in the axial direction of the coil former in such a sequence that the conducting wires from one diode or from a point of support to a cell are only laid over those cells which have already been wound. Although, thereby, the partial windings of certain cells have a considerable separation in the axial direction from the associated diode, this method creates a winding

procedure which still permits automatic winding as in the past. Therefore, depending on the number of cells located between two groups of diodes in the axial direction of the coil former, it can be advantageous to wind various groups of cells successively in a direction opposite to the axial direction so that all cells can be wound and that during the winding procedure, conducting wires running in the axial direction of the coil former are always only laid over those cells only which have already been wound.

The invention will be explained in the following by way of several embodiment examples and by means of the drawing. Therein is shown:

- Fig. 1 the principle of the arrangement of several diodes along the perimeter of the coil former,
- Fig. 2 another view of Fig. 1,
- Fig. 3 a further development of Fig. 2,
- Fig. 4 an embodiment example for a further development of the invention,
- Fig. 5 another view of Fig. 4,
- Fig. 6 the circuit between the partial windings in the cells and the diodes,
- Fig. 7 the winding scheme for a winding procedure according to the invention, and
- Figs. 8 to 10 a particular embodiment of the coil former for attaining a fixed coupling.

Fig. 1 shows a cell coil former 1 with a multiplicity of partial windings for the high voltage transformer arranged in its cells. Four high voltage rectifier diodes 3a, 3b, 3c, 3d, connected to the partial windings in the cells, are arranged distributed around the perimeter at the outer edge of the fin 2. Several such assemblies with four diodes are provided over the total length of the coil former 1, whereby three to five cells each with a partial winding are located between each pair of such assemblies.

Fig. 2 shows a plan view of Fig. 1. In total, three groups each consisting of four diodes 3a through 3d distributed around the perimeter are provided. Between each pair of such groups of diodes are four cells 4 in which the partial windings connected to the diodes are located. The cells 4 are separated from each other by cell walls 5. The fins 2 have a thickness of approximately 2 mm mainly resulting from the diameter of the diodes 3. The cell walls are not so thick, approximately 1 mm, because they only serve to form the cell 4 and to attain the high voltage electric strength. The connecting wires of the diodes 3 are fitted into form-fit catch means on the outer edge of each fin 2. The ends of the windings from the windings in the cells 4 are wound around the connecting wires of the diodes 3 whereby these serve as points of support for the thin winding wires.

Fig. 3 differs from Fig. 2 in that the diodes 3 are not supported on the outer edge of the fin 2 but, rather, are incorporated in a circumferential groove 6 on the outer edge of the fin 2. This solution means that the external diameter of the coil former 1 is not increased by the diodes 3.

Fig 4 shows two cells 4a and 4b with partial windings 7a and 7b. The winding wire 8a emerging from the partial winding 7a at the upper edge of the cell 4a is connected to a terminal of the diode 3. The winding wire 8b of the partial winding 7b in cell 4b is connected to the other terminal of the diode 3. The fin 2 between cells 4a and 4b is provided with a ramp-shamped recess 9 which starts at the upper edge of the fin 2 and extends tangentially towards the cell base 11. The recess 9 is so dimensioned that the fin 2 is not completely interrupted. It can be seen that the winding wire 8b places itself into the recess 9 and is thus

separated from the winding 7b. This is particularly advantageous in the upper region of the winding 7b because here the winding, in relation to the winding wire 8b, already conducts the full impulse voltage of the winding 7b. Despite the recess 9, the fin 2 maintains its insulation effect between cells 4a and 4b. In particular it is ensured that despite the recess 9, no direct connection between cells 4a and 4b exists, i.e. windings 7a and 7b cannot "see each other directly". The ramp-shaped recess 9 is also provided in the cell walls 5 in order to separate the wire leading to the cell base from the winding located in the cell.

In Fig. 5 the ramp-shaped recess 9 is indicated by the cross-hatched area. At the point on the outer edge of the fin 2 or the cell wall 5 where the ramp-shaped recess 9 starts, a projection (lug) 10 is provided on the fin 2 or the cell wall 5. The projection 10 serves as change-of-direction point for the winding wire 8b and ensures that the winding wire 8b is placed into the recess 9.

Fig. 6 shows the principles of the circuit between the diodes 3 and the partial windings 7 in the cells 4. Each winding wire from the cell base 11 is connected to the anode of the diode and each winding wire from the uppermost layer in the cell 4 is connected to the cathode of the diode 3. The high voltage terminal M1 with the high voltage UH for the kinescope is picked up from the cell base of the last partial winding 7. The uppermost layer of the first partial winding 7 is connected to ground, represented by the point of support M2.

Fig. 7 shows a winding scheme for a coil former with five groups of three or four diodes according to Figs. 1, 2 and three or four or, respectively, five cells 4 according to Fig. 2 located in between. The winding is to produce a

connection between the diodes 3 and the partial windings 7 according to Fig. 6. The squares on the electrodes of the diodes always indicate the two connecting wires of the diodes or the points of support to which the winding wires are fed. Five wide fins 2a through 2e are illustrated, each of which supports four diodes 3a through 3d. The cells 4a through 4p formed by the cell walls 5 are incorporated between the fins 2a through 2e and said cells are each filled, either partly or completely, with a partial winding 7. The winding starts at the point of support connected to M1 and is led to the base of the cell 4a. The winding wire from the upper cell edge of the cell 4a is connected to the cathode of diode 3b on fin 2a. The winding wire from the anode of diode 3b is fed into the cell 4b, and the winding wire from the uppermost layer of the winding in cell 4b is connected to the cathode of diode 3c, the anode of which is connected to the cell base of cell 4c. The cells 4a through 4p are wound in this way, whereby the partial windings are connected to the connecting wires of the diodes 3 at the same time. It can be seen that the connecting wires respectively from one terminal of diode 3 to the corresponding cell are always only laid over those cells which have already been wound. Thus, an automatic winding procedure is rendered possible although the connecting wires between each diode and the winding of the associated cell, extend in the axial direction of the coil former over several cells.

In cell 4k it is indicated that the winding wire enters cell 4k twice and leaves cell 4k twice. Thereby, a pick-off within a winding for the generation of the focusing voltage is indicated. The focusing voltage can be picked up at point of support M3 which is not connected to any diode 3. The winding of cell 4l begins, at first, exactly like the winding of cells 4a, 4e, 4i. The winding wire which emerges later from the cell 4m is firstly fixed to the

cathode of diode 3c on fin 2d, and the winding procedure at this diode is, at first, not continued. This is based on the fact that otherwise, owing to the, in total, five cells 4l through 4p between the groups of diodes of the fins 2d and 2e, the requirement that the feeding back of the wires only over cells which have already been wound can no longer be maintained. The winding procedure is instead continued from the right-hand end of the coil former. The winding starts at 'A' at the base of cell 4p. Point 'A' corresponds to the corresponding point 'A' in Fig. 6. The winding wire emerging from cell 4p at the uppermost layer is fed to one end of the wire bridge which belongs to the point of support M2 which is grounded according to Fig. 6. Thereby, this winding procedure is also concluded, for the time being. Following this, the winding wire is fed from the anode of diode 3a on fin 2e into the cell 4o and from its uppermost layer to the connecting wire of the cathode of diode 3c on fin 2e. Thereby, this winding procedure is also concluded. Subsequently, the winding wire from the anode of diode 3c on fin 2d is fed into the cell 4n and exits this from the uppermost layer. The winding wire is now fed via the cells 4o and 4p to the cathode of diode 3a on fin 2e. That is now possible because cells 4o and 4p have already been wound in the previous winding procedures as described.

It can be seen that some points of support like M21, M22 and M23 are not provided with a diode. One terminal then always serves for the fixing of the winding wire and the other, terminal connected therewith serves for soldering on the corresponding line towards the high voltage clamp UH or towards ground. This solution has the advantage that when soldering the wire onto one end of the point of support, the soldered joint at the other end of the point of support with the winding wire can no longer be impaired.

The sequence in which, according to Fig. 7, individual groups of cells 4 are wound and connected to the appropriate diodes is almost random. The only requirement which must be observed is that the winding wires of the windings which extend in the axial direction of the coil former may only be laid over those cells which have already been wound, because afterwards, winding of these cells is excluded.

With a transformer of the type described, several auxiliary windings, for example, for the heating of the kinescope, for additional operating voltages or flyback impulses, are firstly wound onto the coil former through which the core projects, then, on top of that, the primary winding and, over that, the high voltage winding of the transformer. The auxiliary windings have, as a rule, different numbers of windings, different numbers of winding layers and different wire diameters. The auxiliary windings thus have different heights with respect to the base of the coil former and also breaks between the individual windings. This results in a very irregular progression on the upper side of the windings. Therefore, it ensues that primary winding which is wound on top of that also has an irregular progression on its surface. The secondary winding for the high voltage wound over the primary winding can, however, not be wound directly on to the primary winding. Rather, for reasons of the high voltage electric strength, an additional coil former above the primary winding is necessary which supports the secondary winding. The irregular surface of the primary winding therefore results in an impaired coupling between primary and secondary winding.

Through a further development of the invention according to Figs. 8 through 10 and claims 11 through 12, the task is therefore solved of building the coil former so that, despite the irregularities in the surface of the

auxiliary windings, the coupling between the primary winding and the secondary winding is not impaired.

In this solution, therefore, the irregular build-up of the auxiliary windings with different heights and breaks is deliberately left unchanged. Instead, a sleeve acting as an intermediate bottom is inserted above the auxiliary windings which now forms a defined, smooth base for winding the primary winding yet to be wound, without bumps and depressssions. It is then possible, using this newly created, smooth foundation without irregularities, to wind on the primary winding in successive layers "cleanly" so that the upper edge of the primary winding also has a cleanly defined progression without interruptions. Thereby, a defined, minimum gap between the primary winding and the high voltage winding can be maintained, said gap being necessary for achieving the high voltage electric strength.

Use of the sleeve means that the coupling between the primary winding and the auxiliary windings is slightly reduced. However, this does not result in a disadvantage because this coupling is, relatively speaking, not critical.

Fig. 8 shows a simplified representation of a high voltage transformer with a core 21 upon which the coil former 22 is arranged. At the base of the coil former 22 several auxiliary windings 23 with differing numbers of windings, different layers and different wire diameters are wound. There thus results an irregular progression of the surface of the windings 23. The sleeve 24 surrounding the windings 23 is inserted above the auxilary windings 23; said sleeve is made from synthetic material and has a wall thickness of 2/10 to 6/10 mm. The primary winding 25 with three layers is wound as a "clean" winding onto the sleeve 24. The defined, smooth foundation formed by the sleeve 24

creates the prerequisite for a smooth progression of the surface of the winding 25 without highs or lows.

The coil former 22 is surrounded by the coil former 26. The coil former 26 is constructed as a cell coil former having a multiplicity of cells 28 formed by cell walls 27. The partial windings 29 of the secondary winding or high voltage winding are located in the cells 28. The partial windings 29 are connected with each other via high voltage rectifier diodes according to the principle of the diode split transformer.

In Fig. 9 the coil former 22 is provided with a multiplicity of nipples (raised points) 210 on its surface which are distributed more or less evenly across the perimeter and the axial length. The height of the nipples 210 above the base of the coil former 22 is slightly greater than the maximum height of the auxiliary windings 23. The nipples 210 form support points for the sleeve 24 and have the effect that the sleeve 24 is held at a defined distance from the cell base over the entire perimeter and entire length of the coil former 22, and that it is not dented by the auxiliary windings 23 or the primary winding 25. The nipples 210 also serve for fixing the wires for the auxiliary windings 23 in the axial direction. The gaps between the nipples 210 serve for feeding back wires of the auxiliary windings 23 always to one end of the coil former 22. This multitude of nipples 210 distributed over the perimeter and length means that a relatively thin material of approximately 0.2 to 0.6 mm can be used for the sleeve 24.

In accordance with Fig. 10, the sleeve is provided with a slit 211 running in the axial direction. Thereby, it is rendered possible that the sleeve 24 can be mounted on the coil support 22 through spreading according to the type of a

snap ring in the radial direction or the axial direction 213. The sleeve 24 is built flexibly resilient in the radial direction in such a way that it contacts the upper edges of the nipples 210 automatically. The perimeter of the sleeve 24 is so dimensioned that in the *in situ* condition, the sleeve does not close completely but forms a slit 211 between its ends. The coil former 22 is provided with a dog 212 which engages the slit 211 after mounting radially or axially. Thereby, the sleeve 24 is prevented from rotating relative to the coil former 22.

The entire assembly according to Figs. 8, 9 or 10 without the core is bedded in a sealing compound in a known manner. In doing this, additional fixing and positioning of the sleeve 24 is guaranteed. The diameter of the wires in the primary winding 25 is relatively large, approximately 0.5 to 1 mm. Therefore, it can be advisable to use stranded conductor as winding wire for the primary winding 25 and, if applicable, for the auxiliary windings 23. Stranded conductor is known to be considerably more supple than massive copper wire so that the automatic winding procedure is made easier and, if applicable, the available winding space is even better utilized than with a massive copper wire.

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Patent Claims



1. Diode split high voltage transformer for a television receiver with several partial windings located in cells of a coil former and diodes arranged on cell walls, characterised in that in each case several switched diodes are arranged over a perimeter of a fin (2) of the coil former (1), distributed uniformly over the fin and between different partial windings (4), without mutual offset in the axial direction.
2. Transformer according to claim 1, characterised in that four diodes (3a to 3d) are arranged along the perimeter of the fin (2).
3. Transformer according to claim 1, characterised in that the diodes (3) are located on the outer edge of the fin (2) or in a circumferential groove (6) on the outer edge of the fin (2).
4. Transformer according to claim 1, characterised in that the diodes (3) with their connecting wires are mounted by interlocking catch means on the fin (2).
5. Transformer according to claim 4, characterised in that the connecting wires serve as points of support for fixing the ends of the wires (8a, 8b) of the partial windings (7).
6. Transformer according to claim 1, characterised in that each fin (2) or each cell wall (5) comprises a ramp-shaped recess (9) running tangentially from its outer edge to the cell base (11) without completely interrupting the fin (2) or the cell wall (5), and the winding wire (8b) is fed through said



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recess from a diode terminal or a point of support on the cell edge to the cell base (11).

7. Transformer according to claim 1, characterised in that on the outer edge of the fin (2) or the cell wall (5) at the point where the ramp-shaped recess (9) starts, a projection (10) in the radial direction is provided as a change-of-direction point for the winding wire (8b).

8. Transformer according to claim 1, characterised in that winding wires (28) run from a diode terminal or a point of support to the base of a cell (4) in the axial direction of the coil former (1) across several wound cells.

9. Method for winding a transformer according to claim 8, characterised in that the cells (4) next to each other in the axial direction of the coil former (1) are wound in such a sequence that the winding wires from a diode (3) or a point of support (M) to a cell (4) are only laid over those cells which have already been wound.

10. Method according to claim 9, characterised in that the sequence in the axial direction in which the individual cells (4) are to be wound is opposite for successive groups of cells (4).

11. Transformer according to claim 1, characterised in that auxiliary windings (23) with a primary winding (25) on top and a secondary winding (29) on top of that lie on a coil former (22), and a sleeve (24) is arranged over the auxiliary windings (23) which forms an essentially smooth winding foundation for the primary winding (25).



12. Transformer according to claim 11,¹⁵ characterised in that the coil former (22) comprises nipple-type projections (210) distributed over its perimeter and its length serving as support points for the sleeve (24), and the height of said projections is slightly more than the maximum height of the auxiliary windings (23).